CLAIMS

What is claimed is:

1. An etch solution comprising tetramethylammonium hydroxide ("TMAH") and at least one organic solvent, wherein the etch solution is formulated to selectively etch a silicon layer relative to at least one of a metal layer, an oxide layer, a polyimide layer, and a nitride layer.

2. The etch solution of claim 1, wherein the at least one organic solvent comprises at least one hydroxyl group.

3. The etch solution of claim 2, wherein the at least one hydroxyl group is capable of dissociating and forming at least one hydroxyl ion.

4. The etch solution of claim 1, wherein the at least one organic solvent is selected from the group consisting of isopropanol, butanol, hexanol, phenol, glycol, glycerol, ethylene glycol, propylene glycol, glycerin, and mixtures thereof.

5. The etch solution of claim 1, wherein the at least one organic solvent comprises propylene glycol.

6. The etch solution of claim 1, wherein the etch solution is substantially free of water.

7. The etch solution of claim 1, wherein the TMAH is present in an amount ranging from approximately 1% by weight to approximately 10% by weight.

8. The etch solution of claim 1, wherein the TMAH is present at approximately 6% by weight.

9. The etch solution of claim 1, wherein the etch solution comprises approximately 6% TMAH and approximately 94% propylene glycol.

10. A method of selectively etching silicon, comprising:

exposing a silicon layer on a semiconductor substrate to an etch solution comprising a tetramethylammonium hydroxide ("TMAH") and at least one organic solvent; and

removing the silicon layer without removing at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer also present on the semiconductor substrate.

11. The method of claim 10, wherein exposing the silicon layer on the semiconductor substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising TMAH and at least one organic solvent that comprises at least one hydroxyl group.

12. The method of claim 10, wherein exposing the silicon layer on the semiconductor substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising TMAH and at least one organic solvent having at least one hydroxyl group that dissociates and forms at least one hydroxyl ion.

13. The method of claim 10, wherein exposing the silicon layer on the semiconductor substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising TMAH and at least one organic solvent selected from the group consisting of isopropanol, butanol, hexanol, phenol, glycol, glycerol, ethylene glycol, propylene glycol, glycerin, and mixtures thereof.

14. The method of claim 10, wherein exposing the silicon layer on the semiconductor substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising TMAH and propylene glycol.

15. The method of claim 10, wherein exposing the silicon layer on the semiconductor substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising from approximately 1% by weight to approximately 10% by weight of TMAH.

16. The method of claim 10, wherein exposing the silicon layer on the semiconductor substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising approximately 6% by weight of TMAH.

17. The method of claim 10, wherein exposing the silicon layer to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon layer to an etch solution comprising approximately 6% TMAH and approximately 94% propylene glycol.

18. A method of removing a heat-affected zone ("HAZ") on a semiconductor substrate, comprising:

forming a HAZ in a silicon substrate; and

removing the HAZ without removing at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer present on the silicon substrate.

19. The method of claim 18, wherein forming the HAZ in the silicon substrate comprises forming the HAZ by laser ablation.

20. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising tetramethylammonium hydroxide ("TMAH") and at least one organic solvent.

21. The method of claim 20, further comprising removing at least a portion of the silicon substrate other than within the HAZ with the etch solution.

22. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising TMAH and at least one organic solvent that comprises at least one hydroxyl group.

23. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising TMAH and at least one organic solvent having at least one hydroxyl group that dissociates and forms at least one hydroxyl ion.

24. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising TMAH and at least one organic solvent selected from the group consisting of isopropanol, butanol, hexanol, phenol, glycol, glycerol, ethylene glycol, propylene glycol, glycerin, and mixtures thereof.

25. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising TMAH and propylene glycol.

26. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising from approximately 1% by weight to approximately 10% by weight of TMAH.

27. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising approximately 6% by weight of TMAH.

28. The method of claim 18, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises exposing the silicon substrate to an etch solution comprising approximately 6% TMAH and approximately 94% propylene glycol.

29. A method of removing a heat-affected zone ("HAZ") from a blind opening, comprising:

providing a semiconductor substrate having a HAZ in a blind opening thereon;

removing the HAZ without removing at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer on the semiconductor substrate.

30. The method of claim 29, wherein providing the semiconductor substrate having the HAZ in the blind opening thereon comprises providing a semiconductor substrate comprising silicon.

31. The method of claim 29, wherein providing the semiconductor substrate having the HAZ in the blind opening thereon comprises providing the semiconductor substrate comprising at least one of an oxide layer, a metal bond pad, a metal layer, and at least one polyimide layer on the semiconductor substrate.

32. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer on the semiconductor substrate comprises removing the HAZ to expose at least a portion of the semiconductor substrate.

33. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising tetramethylammonium hydroxide ("TMAH") and at least one organic solvent.

34. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising TMAH and at least one organic solvent that comprises at least one hydroxyl group.

35. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising TMAH and at least one organic solvent having at least one hydroxyl group that dissociates and forms at least one hydroxyl ion.

36. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising TMAH and at least one organic solvent selected from the group consisting of isopropanol, butanol, hexanol, phenol, glycol, glycerol, ethylene glycol, propylene glycol, glycerin, and mixtures thereof.

37. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising TMAH and propylene glycol.

38. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising from approximately 1% by weight to approximately 10% by weight of TMAH.

39. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising approximately 6% by weight of TMAH.

40. The method of claim 29, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer comprises removing the HAZ with an etch solution comprising approximately 6% TMAH and approximately 94% propylene glycol.

41. The method of claim 29, further comprising removing at least a portion of the semiconductor substrate.

42. The method of claim 41, wherein removing the at least a portion of the semiconductor substrate comprises removing the at least a portion of the semiconductor substrate to expose the oxide layer.

43. The method of claim 29, further comprising smoothing at least a portion of the semiconductor substrate with an etch solution comprising ammonium fluoride, phosphoric acid, water, hydrogen peroxide, and at least one organic solvent.

44. The method of claim 29, further comprising removing at least a portion of the oxide layer with an etch solution to expose a metal bond pad.

45. A method of forming an aperture in a through-wafer interconnect, comprising:

exposing a silicon substrate to a laser beam to form an aperture, wherein the laser beam forms a heat-affected zone ("HAZ") on the silicon substrate;

exposing the silicon substrate to an etch solution comprising tetramethylammonium hydroxide ("TMAH") and at least one organic solvent; and

removing the HAZ without removing at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer present on the silicon substrate.

46. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising TMAH and at least one organic solvent that comprises at least one hydroxyl group.

47. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising TMAH and at least one organic solvent having at least one hydroxyl group that dissociates and forms at least one hydroxyl ion.

48. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising TMAH and at least one organic solvent selected from the group consisting of isopropanol, butanol, hexanol, phenol, glycol, glycerol, ethylene glycol, propylene glycol, glycerin, and mixtures thereof.

49. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising TMAH and propylene glycol.

50. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising from approximately 1% by weight to approximately 10% by weight of TMAH.

51. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising approximately 6% by weight of TMAH.

52. The method of claim 45, wherein exposing the silicon substrate to the etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to an etch solution comprising approximately 6% TMAH and approximately 94% propylene glycol.

53. The method of claim 45, further comprising filling the aperture with a conductive material to form the through-wafer interconnect.

54. The method of claim 45, further comprising removing at least a portion of the silicon substrate with the etch solution.

55. A method of forming a through-wafer interconnect, comprising:
exposing a silicon substrate to a laser beam to form an aperture, wherein the laser beam forms a heat-affected zone ("HAZ") on the silicon substrate;
removing the HAZ without removing at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer present on the silicon substrate; and
filling the aperture with a conductive material to form a through-wafer interconnect.

56. The method of claim 55, wherein removing the HAZ without removing the at least one of a metal layer, an oxide layer, a nitride layer, and a polyimide layer present on the silicon substrate comprises exposing the silicon substrate to a first etch solution comprising tetramethylammonium hydroxide ("TMAH") and at least one organic solvent.

57. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising TMAH and at least one organic solvent that comprises at least one hydroxyl group.

58. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising TMAH and at least one organic solvent having at least one hydroxyl group that dissociates and forms at least one hydroxyl ion.

59. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising TMAH and at least one organic solvent selected from the group consisting of isopropanol, butanol, hexanol, phenol, glycol, glycerol, ethylene glycol, propylene glycol, glycerin, and mixtures thereof.

60. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising TMAH and propylene glycol.

61. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising from approximately 1% by weight to approximately 10% by weight of TMAH.

62. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising approximately 6% by weight of TMAH.

63. The method of claim 56, wherein exposing the silicon substrate to the first etch solution comprising TMAH and the at least one organic solvent comprises exposing the silicon substrate to the first etch solution comprising approximately 6% TMAH and approximately 94% propylene glycol.

64. The method of claim 55, further comprising removing at least a portion of the silicon substrate with a second etch solution to enlarge a diameter of the aperture.

65. The method of claim 55, further comprising removing at least a portion of the silicon substrate with a second etch solution comprising ammonium fluoride, phosphoric acid, water, hydrogen peroxide, and at least one organic solvent

66. The method of claim 55, further comprising smoothing at least a portion of the silicon substrate with a second etch solution comprising ammonium fluoride, phosphoric acid, water, hydrogen peroxide, and at least one organic solvent.

67. The method of claim 55, further comprising forming a passivation layer on sidewalls of the aperture before filling the aperture with the conductive material.